International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)
ISSN (P): 2249-6890; ISSN (E): 2249-8001
Vol. 9, Issue 4, Aug 2019, 263-268


# THE FEA VALIDATION OF SIDE UNDERRUN PROTECTION DEVICE (SUPD) FOR HEAVY COMMERCIAL VEHICLES

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***ABSTRACT***

***There exists a large mismatch between a passenger vehicle and heavy commercial vehicle so it may lead to fatalities or injuries when a light passenger vehicle like bicyclist or a motorcyclist is collided with the lateral side of a heavy vehicle. This paper aims to study& develop a new model of a side Under ride protection device (SUPD) used for heavy commercial vehicles like trucks in order to avoid or reduce any road fatalities or injury to unprotected road users like pedestrians or bicyclists due to side impact to a heavy commercial vehicles. In this work, the design of SUPD is optimized by using FEA, which meets the requirements of I. S. standard. This study also ensures the quality and feasibility of manufacturing which leads to greater occupant safety in case of any accident.***

***KEYWORDS: SUPD, FEA, I. S. Standards, Bicyclists & Heavy Vehicles***

**Received**: May 05, 2019; **Accepted**: May 27, 2019; **Published**: Jun 24, 2019; **Paper Id.**: IJMPERDAUG201927

**Original Article**

## INTRODUCTION

Presently, in countries like India underride is a very common phenomenon. It happens when a relatively small vehicle like a biker, bicyclist, pedestrian or a passenger car, collides with heavier commercial vehicles like trucks. The underride may be of three types like front underride, side underride & rear underride (Galipeau-Belair et. al. 2013). So due to sudden impact, any of these underrides causes severe fatal injury to the occupants as well as to the passenger also. Hence, suitable safety devices can be installed in any of these areas in order to eliminate the underride effect of the small vehicles and to improve the interaction between the vehicles. Therefore, in order to achieve the primary objective of this impact testing, it becomes mandatory to design, construct and test the lateral underride protection device for heavy commercial vehicles (P. Galipeau-Belair et. al. 2014). FEA becomes a great tool to design & then check the durability as well as safety aspects of the vehicle components in a quick succession of time. The main advantage of FEA is that it predicts very accurate results without any physical test hence offers great monitory expenses. A huge amount of surveys have been conducted in the world over the past years to record collision of passenger vehicle especially bicyclists or pedestrians with heavy vehicles. These facts reflect the severity of injuries and the amount of fatalities that happened due to the collisions (Rahul V. Gadekar, 2015). In November 2015, a report published by the ROSPA (Royal Society for Prevention of Accidents) which shows that in the year 2014 road accident of around 21,287 cyclists was reported. Out of which 3,514 were killed or seriously injured & about 17,773 people were slightly injured. For London, about 20% of total cyclist fatalities involved heavy goods vehicle (HGV). In India, National Crime Records Bureau, Delhi recorded similar data and prepared a

report related to number of fatalities vs. population (in millions) from the year 1997 to 2007. These records are shown in Table 1. The official road traffic crash data does not cover the fatalities by road user in India. These data's are only available from some cities and the studies are done only on some selected localities on highways (rural).

**Table 1: Road Traffic Fatalities in India**

| Year | No. of Fatalities | Population (Million) | Fatalities/ Million Persons |
|---|---|---|---|
| 1997 | 77,000 | 955 | 81 |
| 1998 | 79,900 | 971 | 82 |
| 1999 | 82,000 | 987 | 83 |
| 2000 | 78,900 | 1,002 | 79 |
| 2001 | 80,900 | 1,027 | 79 |
| 2002 | 84,059 | 1,051 | 80 |
| 2003 | 84,430 | 1,068 | 79 |
| 2004 | 91,376 | 1,086 | 84 |
| 2005 | 98,254 | 1,103 | 89 |
| 2006 | 105,725 | 1,120 | 94 |
| 2007 | 114,590 | 1,136 | 101 |

A report on "ROAD ACCIDENTS IN INDIA" published in an international journal sponsored by the International Association of Traffic and Safety Sciences also provides some useful data of traffic fatalities in Delhi and some selected locations on national highways. According to this report in Delhi during the year, 2001-2005 around 53% of total fatalities reported were pedestrians and 10% were bicyclists. On the other hand, in the year 1999 on national highways, around 32% of total fatalities were pedestrians and 11% were bicyclists (Dinesh Mohan, 2009). Therefore, these data show that bicyclists and pedestrian are major sectors of total traffic fatalities in India.

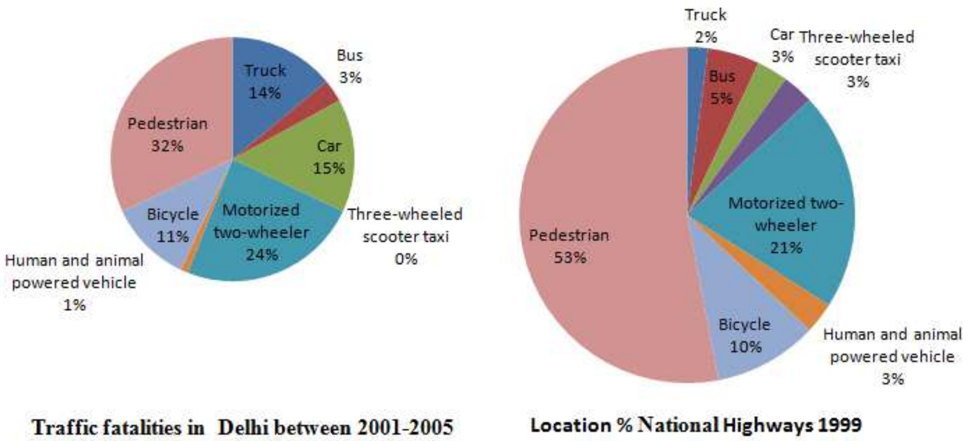


**Figure 1: Traffic Fatalities of Road User in Delhi and selected Locations on National Highways**

Indian roads, which are considered for the highest amount of fatalities/injuries in the whole World, now it became more dangerous in the year 2015. According to the statistics obtained from the Times of India, April 2016, the number of deaths are raised to 1.46lakh/year i. e. nearly there is a rise of 5% which means around 400deaths/day occurs in India as compared to previous years. National Transportation Safety Board (NTSB) studied that about 500 deaths/year accounts to collision with the side of tractor- trailers and many of these deaths recorded due to side underride. The researcher also found that the current underride guards' standards are outdated so revisions have to be made to protect passenger vehicles from fatalities & serious injuries. According to NTSB around 29% of pedestrian fatalities and 55% of cyclist fatalities occurred due to collision with the side of the truck.

The main objective of this research is to understand the collision statistics for the side crash between heavy commercial vehicles and bicyclist/pedestrian for determining the need for the suitable guards. No. of researches have been performed in this area to provide the efficient solution to this problem. In order to achieve the current objective of this research it is necessary to create & design a process for developing more suitable, feasible & a robust side underride guards for heavy vehicles. In the current work finite element modeling has been performed for the heavy commercial vehicles to demonstrate the effectiveness of the system along with their benefits during these types of crashes.

**Side underride protection device Standards and Regulations (IS14682-2004)**

The IS14682-2004standards and regulations for side guards are as follows: -

- The length of the side guard should not exceed the overall width of the vehicle.
- The guard is suitable for $M_{2,}$ $M_{3,}$ $N_{2,}$ $N_{3,}$ $T_3$ & $T_4$class of vehicles.
- The ground clearance of the side guard must not exceed 550 mm.
- The position of the guard must be such that the forward edge of the side guard is limited to a maximum of 300 mm from the rearmost part of the front tyre. In the same way, the distance between the rearmost edge of the side guard & foremost part of the rear wheel should not be more than 300 mm.
- The upper edge of the side guard is also limited to a maximum of 350 mm below the frame of the vehicle.

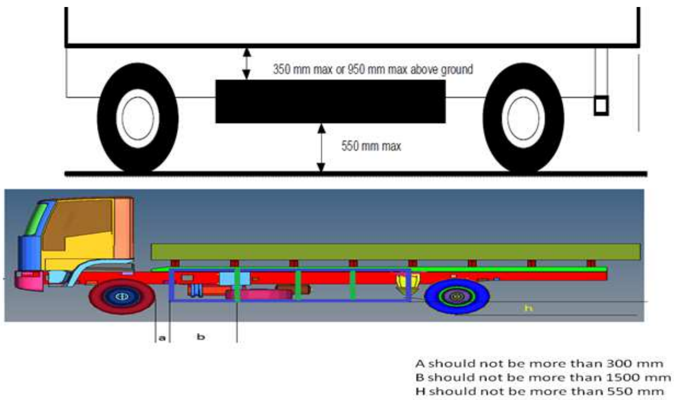


**Figure 2: IS14682-2004 Lateral Protection Device Dimensions**

**Test Passing Criteria of Side Underride Protection Device (IS14682-2004)**

The side underride protection device shall be considered more suitable and efficient if it could withstand a horizontal static force of 1kN (1000N) which is applied normally to any part of its external surface. This horizontal force is applied by a flat and circular ram of diameter 220 ± 10 mm. In addition, the deflection produced on the guard due to applied load must be less than150 mm.

## METHODOLOGY

In order to design and validate a suitable& robust Side guard to provide safety to unprotected road users like pedestrian, bicyclist or 2 wheeler riders, the SUPD standards & regulations have been already introduced as per Indian Standards (IS14682-2004) which we have already discussed in detail. For this purpose, the complete work is broadly divided into 4 specific aims.

- Specific Aim I:-Understand Side under Run Protection Device (SUPD) and its Government Norms and Regulation
- Specific Aim II:- Develop Side under Run Protection Device (SUPD) CAD and Finite Element (FE) model as per given dimensions given in regulation
- Specific Aim III:- Setup FE Model as per test standard to test the SUPD design
- Specific Aim IV: - Final Optimized Design.

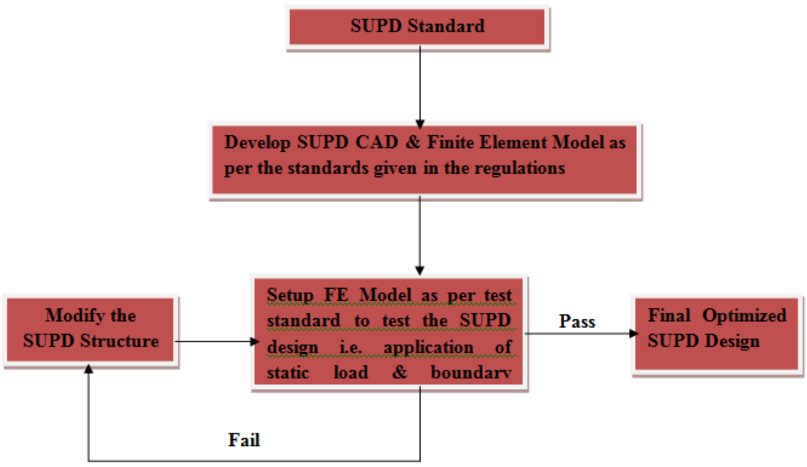


**Figure 3: Flow Chart of Design Process using FEA**

For the test purpose SUPD model is Designed & developed with the help of Finite Element Method. FE modelling is done by using Hypermesh as pre- processor. The material model used for SUPD structure is Steel (FE 410). Now SUPD structure is tested virtually by using FEA as per the test criteria that have been discussed before.

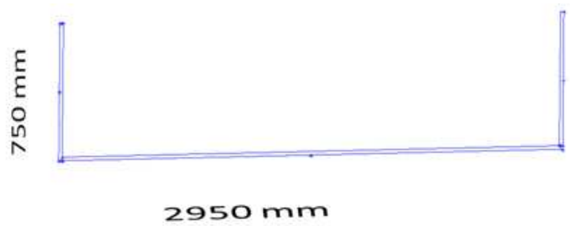


**Figure 4: SUPD Model Development using FEA**

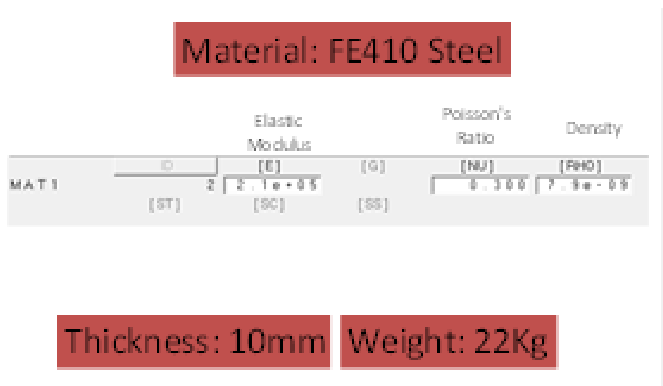


**Figure 5: Selection of Parameters using FEA**

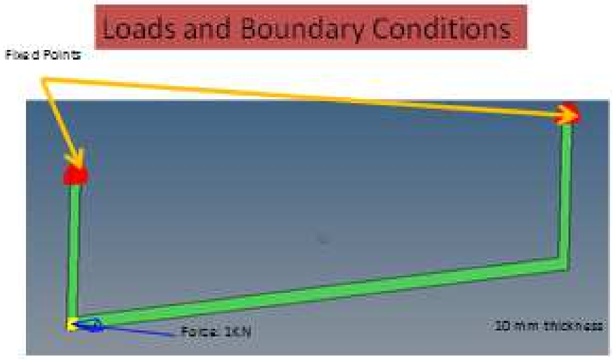


**Figure 6: FE Model as per Test Standard to Test the Supd Design**

## RESULTS & CONCLUSIONS

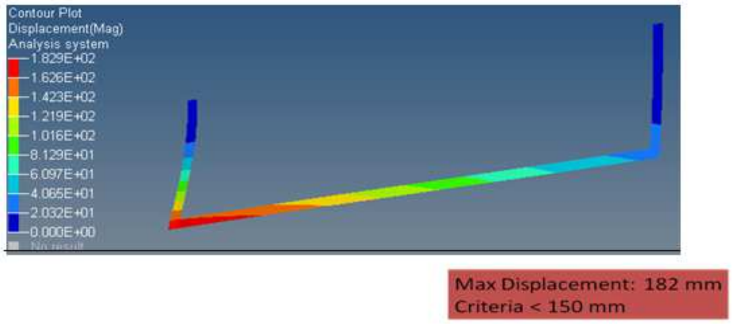


**Figure 7: FEA of Side Underride Protection Device (Thickness=8 mm)**

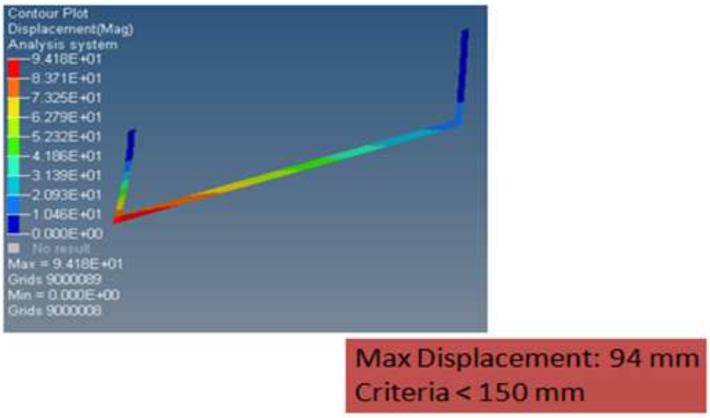


**Figure 8: FEA of Side Underride Protection Device (Thickness=10mm)**

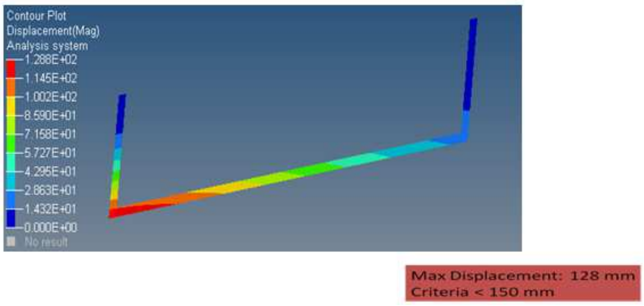


**Figure 9: FEA of Side Underride Protection Device (Thickness=9mm)**

In the current work, proposed design of SUPD has been analyzed for three different thicknesses. In the first case, thickness (t) is 8mm for which the maximum deflection is found to be 182 mm, which does not fulfill the SUPD test passing criteria. In the second case, thickness (t) is 10mm where the maximum deflection is found to be 94mm, which fulfills the side guard test passing criteria. But in the third case when thickness (t) is 9 mm, the maximum deflection is found to be 128mm (i. e. less than 150mm) along with the reduction in weight as compared to when t=10mm. Therefore, the optimum thickness of the proposed design of SUPD will be 9 mm (i. e. second case). In this case, the maximum deflection of the guard is about 14% less than the deflection criteria of side guards as defined by I. S. standards.

## ACKNOWLEDGEMENTS

The authors are thankful to Suresh Gyan Vihar University, Jaipur (India) for supporting this project. We are also thankful to Mr. Sumit Sharma (CAE engineer, Eicher Motors, Indore) for his support over the course of the research.

### *REFERENCES*

1. *The Royal Society for the Prevention of Accidents (ROSPA), 28 Calthorpe Road, Edgbaston, Birmingham B15 1RP.*
2. *IS14682:2004, automotive vehicle-lateral Protection (side guards) — technical Requirements.*
3. *Mohan, D. (2009). Road accidents in India. International Association of Traffic and Safety Science, 33(1).*
4. *Galipeau-Belair, P., El-Gindy, M., Critchley, D., Ramachandra, S., Ghantae, S. (2013). A Review of Side Underride Statistics and Protection Device Literature and Designs. Int. J. of Heavy Vehicle Systems, 20(4):361-374.*
5. *Galipeau-Belair, P., El-Gindy, M., Critchley, D., Ramachandra, S., Ghantae, S. (2013). Development of a regulation for testing the effectiveness of a rigid side underride protection device (SUPD)", International Journal of Crashworthiness.*
6. *Lin, Z. P., Wang, H. S., & Tsai, S. J. (2016). The Intelligent Charging Path Planning for Electric Vehicle. International Journal of Computer Networking, Wireless and Mobile Communications (IJCNWMC) ISSN (P), 2250-1568.*
7. *Galipeau-Belair, P., El-Gindy, M., Critchley, D., Ramachandra, S., Ghantae, S. (2014). Optimized Rigid Side Underride Protection Device Designs for Tractor-Trailers and Straight Trucks, SAE World Congress 2014.*
8. *Traffic Safety Facts – 2010. National Highway Traffic Safety Administration, National Center for Statistics and Analysis, U. S. Department of Transportation, Washington, DC 20590 (2012).*

   *https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/811659*
9. *Padmanaban, J., Martz, B., Salvage, J. (2008). Evaluation of Light Vehicle Side Underride Collisions into Combination Trucks. SAE International Journal of Commercial Vehicles, 1(1): 473-480.*
10. *Gadekar, R. V., Kadam, M. A., Kadam S. S., (2015). Flexibility of existing SUPD designs for impact load testing of motorbikes. International Journal of Engineering Sciences & Research Technology.4(6):482-87.*